

Dear FCC Staff:

Here is additional information and references on health and safety I think are important to consider for your decision to roll out the extensive 5 G wireless system for Docket 16-421. Considering the current science and data gaps in the science of bio-electromagnetics, the addition of more complex electromagnetic frequencies to the telecommunications system with exposure to the entire human population, wildlife and insects, is expected to have significant adverse effects on our health, well-being and sustainability. This may not be readily observed until effects are significant and irreversible.

I believe this 5G rollout to be premature as proper safeguards are not in place to protect the public or the environment, including trees and important pollinators such as bees who because of their size would be especially vulnerable to millimeter wave affects. Studies show special concern for the eye, skin, immune system and nervous system. Vulnerable populations that will be exposed and require additional protections are pregnant women, children, those with chronic illness and the elderly.

Complex biological processes can be affected by this short millimeter radiation which will be layered on top of current longer wave microwave radiation, which has also been shown to be harmful to living organisms.

It is important to have full testing of the frequencies to be used on all living organisms and consider non-thermal affects. Studies have shown a small variation in frequency or modulation in addition to length of exposure can have profound differences in biological effects that are not thermal in nature. Thermal effects also need to be properly tested of course.

This issue needs to be addressed with a formal independent commission with all stakeholders involved including scientists, public health officials, physicians, toxicologists and biologists with complete transparency and inclusion of all scientific data. Please halt this push to accelerate the 5 G rollout including the Mobile Act Now S. 19 and the Digital Act S.88 until we can be assured of the safety of the cell towers and multitude of devices that we are becoming increasingly dependent on and with evidence of harm in many areas.

Respectfully submitted.

Cindy Russell, MD

I am also attaching an article on 5G Wireless technology

5G Scientific Papers-Milimeter Wavelengths (MMW) – Adverse effects

1) Changes in gap junctional intercellular communication in rabbits lens epithelial cells induced by low power density microwave radiation. “To demonstrate the changes in gap junctional intercellular communication (GJIC) mediated by low power density microwave radiation in rabbits lens epithelial cells (LECs) and its mechanisms. Rabbits' eyes were exposed to 5 mW/cm(2) and 10 mW/cm(2) power densities of microwave radiation for 3 hours. Low power densities microwave radiation (5 mW/cm(2) and 10 mW/cm(2)) induces damage to connexin 43 and inhibits the GJIC of rabbits LECs. These changes result in an osmotic imbalance within the lens and induce early cataract. 5 mW/cm(2) or 10 mW/cm(2) microwave radiation is cataractogenic.” Ye, J. [Chin Med J \(Engl\)](https://www.ncbi.nlm.nih.gov/pubmed/12622942). 2002 Dec;115(12):1873-6.
<https://www.ncbi.nlm.nih.gov/pubmed/12622942>

2) [Experimental studies on the influence of millimeter radiation on light transmission through the lens]. Prost, M. Klin Oczna. 1994 Aug-Sep;96(8-9):257-9. "Transmission through the lenses was significantly decreased (about 33%) in the rats exposed to microwave radiation of 10 mW/cm². The results of the study indicate that also microwave radiation in millimetre range can induce changes in the lens, predisposing to cataract development."

<https://www.ncbi.nlm.nih.gov/pubmed/7897988>

3) Does human skin truly behave as an array of helical antennae in the millimeter and terahertz wave ranges? Ney, M. Opt Lett. 2010 Oct 1;35(19):3180-2.

<https://www.ncbi.nlm.nih.gov/pubmed/20890326>

4) Impact of 60-GHz millimeter waves and corresponding heat effect on endoplasmic reticulum stress sensor gene expression.

Bioelectromagnetics. 2014 Sep;35(6):444-51. Le Quément C.

<https://www.ncbi.nlm.nih.gov/pubmed/25099539>

5) Near-field dosimetry for in vitro exposure of human cells at 60 GHz. Zhadobov M.

Bioelectromagnetics. 2012 Jan;33(1):55-64. <https://www.ncbi.nlm.nih.gov/pubmed/21713963>

6) Bose Condensation and non thermal processes in living systems

under millimeter (MM) radiation. Chukova YP. Electromagn Biol Med. 2009;28(1):41-5.

<https://www.ncbi.nlm.nih.gov/pubmed/19337893>

7) Reasons of poor replicability of nonthermal bioeffects by millimeter waves. Chukova

YuP. Bioelectrochem Bioenerg. 1999 May;48(2):349-53.

<https://www.ncbi.nlm.nih.gov/pubmed/10379553>

8) A non-thermal effect of millimeter wave radiation on the puffing of giant chromosomes.

Z Naturforsch C. 1983 Sep-Oct;38(9-10):883-6. Koschnitzke C.

<https://www.ncbi.nlm.nih.gov/pubmed/6649796>

9) Thermal mechanisms of millimeter wave stimulation of excitable cells. Shapiro MG.

Biophys J. 2013 Jun 18;104(12):2622-8.

<https://www.ncbi.nlm.nih.gov/pubmed/23790370>

10) Effects of millimeter wave irradiation and equivalent thermal heating on the activity of individual neurons in the leech ganglion. Romanenko S. J Neurophysiol. 2014 Nov

15;112(10):2423-31. "Many of today's radiofrequency-emitting devices in telecommunication,

telemedicine, transportation safety, and security/military applications use the millimeter wave

(MMW) band (30-300 GHz). To evaluate the biological safety and possible applications of this

radiofrequency band for neuroscience and neurology, we have investigated the physiological

effects of low-intensity 60-GHz electromagnetic irradiation on individual neurons in the leech

midbody ganglia. We applied incident power densities of 1, 2, and 4 mW/cm² to the whole

ganglion for a period of 1 min while recording the action potential with a standard sharp

electrode electrophysiology setup. For comparison, the recognized U.S. safe exposure limit is 1

mW/cm² for 6 min. During the exposure to MMWs and gradual bath heating at a rate of

0.04°C/s (2.4°C/min), the ganglionic neurons exhibited similar dose-dependent hyperpolarization

of the plasma membrane and decrease in the action potential amplitude. However, narrowing of the action potential half-width during MMW irradiation at 4 mW/cm² was 5 times more pronounced compared with that during equivalent bath heating of 0.6°C. Even more dramatic difference in the effects of MMW irradiation and bath heating was noted in the firing rate, which was suppressed at all applied MMW power densities and increased in a dose-dependent manner during gradual bath heating. The mechanism of enhanced narrowing of action potentials and suppressed firing by MMW irradiation, compared with that by gradual bath heating, is hypothesized to involve specific coupling of MMW energy with the neuronal plasma membrane.” <https://www.ncbi.nlm.nih.gov/pubmed/25122711>

11) Modulation of neuronal activity and plasma membrane properties with low-power millimeter waves in organotypic cortical slices. [Pikov V. J Neural Eng.](#) 2010

Aug;7(4):045003.”V The applied levels of MMW power are three orders of magnitude below the existing safe limit for human exposure of 1 mW cm⁻². Surprisingly, even at these low power levels, MMWs were able to produce considerable changes in neuronal firing rate and plasma membrane properties. At the power density approaching 1 microW cm⁻², 1 min of MMW exposure reduced the firing rate to one third of the pre-exposure level in four out of eight examined neurons..... he presented results constitute the first demonstration of direct real-time monitoring of the impact of MMWs on nervous tissue at a microscopic scale. Implication of these findings for the therapeutic modulation of neuronal excitability is discussed.”

<https://www.ncbi.nlm.nih.gov/pubmed/20644247>

12) Current State and Implications of Research on Biological Effects of Millimeter Waves: A Review of the Literature. Andrei G. Pakhomov. Bioelectromagnetics 19:393–413 (1998)

<http://www.rife.org/otherresearch/millimeterwaves.html>

“In recent years, research into biological and medical effects of millimeter waves (MMW) has expanded greatly. The present paper analyzes general trends in this area and briefly reviews most significant publications, proceeding from cell-free systems, dosimetry and spectroscopy issues, through cultured cells and isolated organs to animals and humans. The studies reviewed demonstrated effects of low-intensity MMW (10 mW/cm² and less) on cell growth and proliferation, activity of enzymes, state of cell genetic apparatus, function of excitable membranes, peripheral receptors, and other biological systems. In animals and humans, local MMW exposure stimulated tissue repair and regeneration, alleviated stress reactions, and facilitated recovery in a wide range of diseases (MMW therapy). Many of reported MMW effects could not be readily explained by temperature changes during irradiation. This paper outlines some problems and uncertainties in the MMW research area, identifies tasks for future studies, and discusses possible implications for development of exposure safety criteria and guidelines.”

<http://www.rife.org/otherresearch/millimeterwaves.html>

13) State of knowledge on biological effects at 40–60 GHz. Yves Le Dréan, Yonis Soubere Mahamoud, Yann Le Page, Denis Habauzit, Catherine Le Quément, Maxim Zhadobov, Ronan Sauleau. State of knowledge on biological effects at 40–60 GHz. Comptes Rendus Physique, 14(5): 402-411.2013. <http://fulltext.study/preview/pdf/1860108.pdf>

<http://www.sciencedirect.com/science/article/pii/S1631070513000480>

14) Transcriptome Analysis Reveals the Contribution of Thermal and the Specific Effects in Cellular Response to Millimeter Wave Exposure. Habauzit, D. Oct.14, 2014. PlosOne. “This study aimed therefore to evaluate the biocompatibility of MMW at 60 GHz. For this purpose, we used a whole gene expression approach to assess the effect of acute 60 GHz exposure on primary cultures of human keratinocytes. ...In our experimental design, the high number of modified genes (665) shows that the ICNIRP current limit is probably too permissive to prevent biological response. ... MMW could slightly modify a signaling pathway relative to heat shock response...Thus, we evidence here for the first time, that acute MMW stimulation specifically induces the expression of some secreted genes. Additional studies will be needed to determine what are the molecular mechanisms underlying this cellular response and how could evolve this response after chronic long-term MMW exposure.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4193780/> or
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0109435>

15) Additive Effects of Millimeter Waves and 2-Deoxyglucose Co-Exposure on the Human Keratinocyte Transcriptome. <https://www.ncbi.nlm.nih.gov/pubmed/27529420>

16) [Effects of millimeter wave on gene expression in human keratinocytes]. “Millimeter wave exposure could affect gene expression in human keratinocytes, which might be related to the intensity and the times of exposure.” <https://www.ncbi.nlm.nih.gov/pubmed/18275115>

17) Millimeter wave absorption in the nonhuman primate eye at 35 GHz and 94 GHz. Chalfin S. *Health Phys.* 2002 Jul;83(1):83-90. <https://www.ncbi.nlm.nih.gov/pubmed/12075687>

18) Increased sensitivity of the non-human primate eye to microwave radiation following ophthalmic drug pretreatment. Kues HA. <https://www.ncbi.nlm.nih.gov/pubmed/1445419>

19) [Effect of extremely high frequency electromagnetic radiation of low intensity on parameters of humoral immunity in healthy mice]. Lushnikov KV. *Biofizika.* 2001 Jul-Aug;46(4):753-60. <https://www.ncbi.nlm.nih.gov/pubmed/11558390> “However, after repeated exposures for 20 days before immunization, a statistically significant reduction of thymic cellularity by 17.5% ($p < 0.05$) and a decrease in cellularity of the spleen by 14.5% ($p < 0.05$) were revealed.”

20) [Suppression of nonspecific resistance of the body under the effect of extremely high frequency electromagnetic radiation of low intensity]. Kolomytseva MP. *Biofizika.* 2002 Jan-Feb;47(1):71-7. <https://www.ncbi.nlm.nih.gov/pubmed/11855293> “The results indicated that the whole-body exposure of healthy mice to low-intensity EHF EMR has a profound effect on the indices of nonspecific immunity.”

21) [Effects of low-intensity extremely high frequency electromagnetic radiation on chromatin structure of lymphoid cells in vivo and in vitro]. Gapeev AB. *Radiats Biol Radioecol.* 2003 Jan-Feb;43(1):87-92. <https://www.ncbi.nlm.nih.gov/pubmed/12677665> “We

suggested that the effects of low-intensity EHF EMR on the immune system cells are realized with the participation of neuroendocrine and central nervous systems.”

22) Low power radio-frequency and microwave effects on human electroencephalogram and behavior. Bise W. *Physiol Chem Phys*. 1978;10(5):387-98.

<https://www.ncbi.nlm.nih.gov/pubmed/751078> “Frequencies included .1 to 960 MHz continuous and 8.5 to 9.6 GHz pulse-modulated waves. Since the relaxation frequency of protein-bound water is considered to fall between 100 and 1,000 MHz, absorptions and quantum effects may be the mechanistic basis for the electroencephalogram changes observed in most of the subjects produced by 10(-15) W/cm² cw radio-frequency energy of between 130 and 960 MHz. Constructive and destructive interference patterns from standing waves within the skull possibly interact with the bioelectric generators in the brain, since electroencephalogram wave amplitudes and frequencies increased or decreased respectively at different radio wavelengths.”

23) Millimeter-wave interactions with the human body: State of knowledge and recent advances. Zhadobov, M. *International Journal of Microwave and Wireless Technologies*. React-text: 61 3(02):237 - 247 April 2011.

https://www.researchgate.net/publication/231844703_Millimeter-wave_interactions_with_the_human_body_State_of_knowledge_and_recent_advances
“Before being introduced on the market, millimeter-wave systems should comply with local regulations that are usually based on the ICNIRP and/or IEEE exposure limits. For far-field exposures, the power density (PD) averaged over 20 cm is limited to 1 mW/cm (general public) and to 5 mW/cm (workers) in the 60-GHz band [6, 7]. To respect these limits and due to technological limitations, the typical power radiated by the radio front-ends is below 10 dBm. However, power densities up to 20 mW/cm (general public) and 100 mW/cm (workers) are permitted for local exposure scenarios, i.e. for PD averaged over 1 cm [6]. Exposures under these conditions have had a limited practical interest so far, but should now be studied in detail due to the expected development of body-centric communication systems [5, 8, 9]. In such systems, the antennas might be placed directly on the body inducing localized exposures of the superficial body layers.

In this context, it is fundamental to analyze millimeter wave/human body interactions from electromagnetic (EM) and thermodynamic viewpoints, as well as the potential biological consequences and their power thresholds. ... Future trends of the bioelectromagnetic studies at millimeter waves cover such aspects as investigation of possible synergistic and combined EM/thermal effects, exact determination of power thresholds, and identification of possible biomarkers of the millimeter-wave exposure.”

24) Millimeter waves or extremely high frequency electromagnetic fields in the environment: what are their effects on bacteria?) Soghomonyan D, Trchounian K, Trchounian A. *Appl Microbiol Biotechnol*. 2016 Jun;100(11):4761-71. doi: 10.1007/s00253-016-7538-0. Epub 2016 Apr 18. “These MMW affected *Escherichia coli* and many other bacteria, mainly depressing their growth and changing properties and activity. These effects were non-thermal and depended on different factors. The significant cellular targets for MMW effects could be water, cell plasma membrane, and genome. ... Novel data on MMW effects on bacteria

and their sensitivity to different antibiotics are presented and discussed; the combined action of MMW and antibiotics resulted with more strong effects. These effects are of significance for understanding changed metabolic pathways and distinguish role of bacteria in environment; they might be leading to antibiotic resistance in bacteria. The effects might have applications in the development of technique, therapeutic practices, and food protection technology.”
<http://www.ncbi.nlm.nih.gov/pubmed/27087527?dopt=Abstract>

25) Bactericidal effects of low-intensity extremely high frequency electromagnetic field: an overview with phenomenon, mechanisms, targets and consequences. [Torgomyan H. Crit Rev Microbiol.](#) 2013 Feb;39(1):102-11. “The consequences for EMF interaction with bacteria are the changes in their sensitivity to different chemicals, including antibiotics. These effects are important to understand distinguishing role of bacteria in environment, leading to changed metabolic pathways in bacteria and their antibiotic resistance. This EMF may also affect the cell-to-cell interactions in bacterial populations, since bacteria might interact with each other through EMF of sub-extremely high frequency range.” <https://www.ncbi.nlm.nih.gov/pubmed/22667685>

26) Cell-to-cell communication in response of E. coli cells at different phases of growth to low-intensity microwaves. [Shcheglov VS. Biochim Biophys Acta.](#) 2002 Aug 15;1572(1):101-6.
<https://www.ncbi.nlm.nih.gov/pubmed/12204338>

27) Effect of millimeter-band radiation of nonthermal intensity on the sensitivity of staphylococcus to various antibiotics. Bulgakova VG, Grushina VA, Orlova TI, Petrykina ZM, Polin AN, Noks PP, Kononenko AA, Rubin AB (1996). *Biofizika* 41:1289-1293 (in Russian). <https://www.ncbi.nlm.nih.gov/pubmed/9044624> “The affect of preliminary irradiation of staphylococcus culture by electromagnetic radiation of extremely high frequency (42, 54, 66 + 78 GHz) of nonthermal intensity on the bacteria growth on the media containing various antibiotics is studied. The reliable change in bacteria sensitivity toward 5 antibiotics, mainly having membranotropic properties is observed in the experiments using 14 antibiotics with various mechanisms of action. It has been established that in the presence of subbactericide concentrations of active antibiotics the irradiation could result in both further suppression of bacteria growth and its stimulation. As shown, the development of these effects takes place even in a matter of minutes of preliminary irradiation, and weak changes are observed at further increase of this period up to 60 min.”

28) The electromagnetic response of human skin in the millimetre and submillimetre wave range. [Feldman Y. Phys Med Biol.](#) 2009 Jun 7;54(11):3341-63.
<https://www.ncbi.nlm.nih.gov/pubmed/19430110>

29) Human skin as arrays of helical antennas in the millimeter and submillimeter wave range. [Feldman Y. Phys Rev Lett.](#) 2008 Mar 28;100(12):128102.
<https://www.ncbi.nlm.nih.gov/pubmed/18517913> “Recent studies of the minute morphology of the skin by optical coherence tomography showed that the sweat ducts in human skin are helically shaped tubes, filled with a conductive aqueous solution. A computer simulation study of these structures in millimeter and submillimeter wave bands show that the human skin functions as an array of low-Q helical antennas. Experimental evidence is presented that the spectral response in the sub-Terahertz region is governed by the level of activity of the

perspiration system. It is also correlated to physiological stress as manifested by the pulse rate and the systolic blood pressure.”

30) Biological effects of millimeter-wave irradiation on mice - preliminary results. Bellossi, A., Dubost, G., Moulinoux, J., Ruelloux, M., Himdi, M. & Rocher, C. (2000), IEEE Transactions on Microwave Theory and Techniques, 48(11), 2104-2110. “There were four obvious observations: there is an individual sensitiveness to 60 GHz waves; the survival of mice grafted with L1210 cells could be increased; the growth of Lewis tumor was enhanced; and the activity of Swiss mice was increased. In any way, those effects have to be taken into account, and the authors suggest prudence before using a 60-GHz waves for indoor communications.”

31) Resonance effect of microwaves on the genome conformational state of E. coli cells.

Belyaev IYa. *Z Naturforsch C*. 1992 Jul-Aug;47(7-8):621-7.

<https://www.ncbi.nlm.nih.gov/pubmed/1388519> “It has been established that within the ranges of 51.62-51.84 GHz and 41.25-41.50 GHz the frequency dependence of the observed effect has a resonance nature with a resonance half-width of the order of 100 MHz. The power dependence of the microwave effect within the range of 0.1-200 microW/cm² has shown that a power density of 1 microW/cm² is sufficient to suppress radiation-induced repair of the genome conformational state.”

32) Emerging Synergisms Between Drugs and Physiologically-Patterned Weak Magnetic Fields: Implications for Neuropharmacology and the Human Population in the Twenty-First Century. P.D Whissell. *Curr Neuropharmacol*. 2007 Dec; 5(4): 278–288.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2644491/>

33) Altered blood chemistry and hippocampal histomorphology in adult rats following prenatal exposure to physiologically-patterned, weak (50-500 nanoTesla range) magnetic fields. St-Pierre LS. *Int J Radiat Biol*. 2008 Apr;84(4):325-35.

<https://www.ncbi.nlm.nih.gov/pubmed/18386197>

34) Behavioral changes in adult rats after prenatal exposures to complex, weak magnetic fields. St-Pierre LS. *Electromagn Biol Med*. 2008;27(4):355-64.

<https://www.ncbi.nlm.nih.gov/pubmed/19037784> “These results suggest that prenatal exposure to physiologically-patterned magnetic fields within a specific "window" of intensities that overlap with values found in many human habitats may produce long-term changes in behaviors.”

35) Neurodevelopmental anomalies of the hippocampus in rats exposed to weak intensity complex magnetic fields throughout gestation. Fournier NM. *Int J Dev Neurosci*. 2012

Oct;30(6):427-33. <https://www.ncbi.nlm.nih.gov/pubmed/22867731> “These findings suggest that prenatal exposure to complex magnetic fields of a narrow intensity window during development can result in subtle but permanent alterations in hippocampal microstructure and function that can have lasting effects on behavior.”

